

IMPROVED D&D THROUGH INNOVATIVE TECHNOLOGY DEPLOYMENT

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ABSTRACT

The U.S. Department of Energy's (DOE) Office of Science and Technology (EM-50) has been demonstrating and deploying innovative decontamination and decommissioning (D&D) technologies through its Large-Scale Demonstration Program. Implemented by EM-50's D&D Focus Area, the Large-Scale Demonstration Program will demonstrate over 50 innovative technologies during its first three Large-Scale Demonstration Projects (LSDP). It is anticipated that the innovative technologies that are successfully proven in the LSDPs will be recognized and further deployed in future D&D projects throughout the DOE Weapons Production Complex resulting in reduced D&D costs and a safer working environment.

I. INTRODUCTION

As part of U.S. Department of Energy's (DOE) Office of Science and Technology (EM-50), the Decontamination and Decommissioning (D&D) Focus Area has been effectively demonstrating and deploying innovative D&D technologies through its Large-Scale Demonstration Program. It had become apparent to the D&D Focus Area that better technologies were available from various sources including the commercial nuclear and non-nuclear industries. The D&D Focus Area surmised that these technologies were not readily used in DOE's deactivation and decommissioning projects because the DOE and its contractors were often unwilling to accept the risk and liability of trying technologies that were unproven in the DOE arena. Through its Large-Scale Demonstration Program, the D&D Focus Area has begun to mitigate this risk and is demonstrating and deploying more cost-effective and safer technologies.

II. LSDP IMPLEMENTATION

In the Large-Scale Demonstration Projects (LSDP), innovative D&D technologies are demonstrated and evaluated as part of ongoing DOE deactivation or decommissioning projects. Ideally, the innovative D&D technology is evaluated side-by-side with a comparable baseline technology in the project. Performance data is collected on both the innovative and baseline technology and is evaluated to assist D&D project managers and planners to decide whether or not an innovative technology has advantages over the baseline technology.

A. Integrating Contractor Team

An Integrating Contractor Team manages the technology demonstration aspects of each of the LSDPs. Typically, three or more experienced D&D firms will comprise the Integrating Contractor Team for each LSDP. Often, the Integrating Contractor Team may include university participation and the site management and operating (M&O) or management and integration (M&I) contractor. The management of the LSDP by multiple D&D interests has provided a balanced project management style since different firms may have different perspectives on the benefits of and the need for an innovative technology. In addition, direct knowledge of the LSDP technology demonstrations will be promptly transferred to the Integrating Contractor Team firms. With direct knowledge, these D&D firms will be able to deploy demonstrated technologies to conduct future D&D work at other DOE sites and commercial nuclear facilities.

B. Technology Selection

The Integrating Contractor Team evaluates and selects the suite of innovative technologies to be demonstrated in the LSDP. This team also determines the appropriate comparative baseline technology. The term “innovative,” in regards to technology selection for an LSDP means the following:

- The technology is under development and has not yet been fully demonstrated, or
- The technology demonstration would involve a new application of an existing technology, or
- The technology has been used commercially but has not been tried within the DOE.

Additional criteria used in evaluation of innovative technologies include maturity of the technology; applicability to needs of the project; applicability of the technology to projects at other DOE sites; potential cost and safety benefits; waste volume reduction; hazard reduction; project schedule compatibility; demonstration cost; and amount of demonstration cost-share provided by the technology vendor.

C. LSDP Costs

The D&D Focus Area, the vendors of innovative technologies, and the facility owners share the cost of the LSDPs. Usually, the facility owner is the DOE Environmental Management (EM) Office of Environmental Restoration (EM-40). For deactivation projects, the facility owner is usually the EM Office of Nuclear Materials and Facilities Stabilization (EM-60). In general, the costs associated with demonstration of innovative technologies are provided by the D&D Focus Area while the facility owner is responsible for costs associated with the use of baseline technologies. Vendors are expected to share the costs of their demonstration, since successful demonstration of a technology in a LSDP can provide a rapid avenue to commercialization and acceptance by the end user, regulators, and other stakeholders.

D. LSDP Support

Through an interagency agreement, the D&D Focus Area has acquired the services of the U.S. Army Corps

of Engineers (USACE) to provide an independent cost analysis of baseline and innovative technologies demonstrated in all LSDPs. Based on the cost and performance data collected during demonstration of an innovative technology, the USACE will develop meaningful cost information to support decisions on future implementation of these technologies. With their noted expertise for life-cycle cost estimating and evaluation, the USACE is providing a consistent format and methodology for the cost analyses.

III. CURRENT LSDPs

The D&D Focus Area currently has three ongoing LSDPs that were selected through a competitive Request for Letter Proposal that was issued to DOE's Operations Offices. These projects include the decommissioning of the Chicago Pile 5 (CP-5) Test Reactor at Argonne National Laboratory-East near Chicago, Illinois; decommissioning of the Plant-1 Uranium Processing Complex at the Fernald Environmental Management Project near Cincinnati, Ohio; and the Interim Safe Storage project at the C-Reactor at the Hanford Reservation near Richland, Washington. The LSDP projects are typically 18 to 24 months in duration.

A. CP-5 Test Reactor LSDP

The first LSDP selected was the decommissioning of the Chicago Pile 5 (CP-5) Test Reactor Facility at Argonne National Laboratory - East. This LSDP is focusing on the removal of equipment from the reactor facility and decontamination of the facility for subsequent reuse. The CP-5 test reactor had a thermal power rating of 5 megawatts and was continuously operated for 25 years until its final shutdown in 1979.

Significant work in this LSDP includes removal of the reactor internals and biological shield, decontamination of the fuel rod storage area, decontamination of radioactive material storage and handling facilities including the fuel pool, and decontamination of the building.

TABLE 1
Technology Demonstrations at CP-5

Technologies	Problem Area	Description
Mobile Automated Characterization System	Characterization	Battery-powered, autonomous robot base with a laser positioning system which can detect alpha and beta/gamma contamination
Pipe Explorer	Characterization	In-situ piping characterization system
X-ray Fluorescence Detection	Characterization	In-situ characterization system
Gamma Camera	Characterization	Visual imaging of area radiation levels
SRA Surface Contamination Monitor	Characterization	Consists of a wide area, computer controlled, position sensitive proportional counter that is mounted on a motorized cart (used at CP-5 for beta/gamma).
Pipe Crawler	Characterization	In-situ piping and duct work characterization system
Field Transportable Beta Counter	Characterization	Instrument provides for real-time detection and spectral analysis of Sr-90, Ce-137, Tc-99 and other beta emitters in the 40 picocurie range
In-situ Object Counting System	Characterization	Radiological monitoring system used to measure small levels of contamination on large objects or surfaces
Pegasus Coating Removal System	Decontamination	Coating removal system using strippable chemicals
Centrifugal Shot Blasting	Decontamination	Effectively removes layers of concrete to varying depths, without dust
Flashlamp Decontamination	Decontamination	Intense light breaks the chemical bond between the material and surface. Material residues and gases are collected by vacuum
Rotopeen Scabbling	Decontamination	This decontamination system for concrete surfaces consists of abrading media (Heavy Duty Roto Peen), surface planing equipment, and high volume vacuum
Concrete Milling	Decontamination	Permits selective removal of contaminants from concrete substrate
Advanced Recyclable Media System	Decontamination	Blasting system using recyclable, specially-impregnated sponges
Empore Membrane Separation	Decontamination	Uses ion-exchange resins embedded in membrane material within a net-like fibril matrix to remove contaminants in water
Swing-Free Crane	Dismantlement	Allows a load suspended from a gantry crane to be moved without inducing any undesired swinging motion
Dual-Arm Work Platform	Dismantlement	Provides flexibility for cooperative and coordinated actions by using two robotic arms.
Rosie Mobile Work Station	Dismantlement	An electro-hydraulic, omni-directional locomotor platform with a heavy manipulator mounted on its deck. The heavy manipulator boom can deploy a large number of tools for demolition and decontamination.
Remote Controlled Concrete Demolition System	Dismantlement	Uses a remote-controlled, track-driven, service-robot, known as the Brokk BM 150, that employs an articulated hydraulic boom with various end-effectors to accomplish a variety of tasks
NU-FAB Suit	Health and Safety	One-piece, microporous, disposable, waterproof coverall to be used in hot/wet atmospheres
FHRAM-TEX Cool Suit	Health and Safety	One-piece disposable, breathable, waterproof coverall for hot/wet atmospheres.

The Integrating Contractor Team is lead by Duke Engineering and Services and includes 3M, Commonwealth Edison, ICF Kaiser, Florida International University, and Argonne National Laboratory. This LSDP began in October 1995.

About 30 innovative technologies are expected to be demonstrated during this project. Many of these technologies are listed in Table 1. The following information highlights a few of the technologies demonstrated during the CP-5 LSDP.

1. Centrifugal Shot Blasting. Compared to standard concrete scabbling, Concrete Cleaning, Inc.'s Centrifugal Shot Blasting unit showed substantial promise during the CP-5 LSDP. This technology, which propels hardened steel shot at high speeds to abrade concrete surfaces, effectively removed concrete coatings at a rate of 310 square feet per hour. This self-propelled unit has a built-in dust and debris collection system that recycles the steel shot and significantly reduces the amount of airborne dust generated. The shot blast unit can be adjusted to remove the entire coating layer, specific layers of the coating, or the coating plus up to ½ inch of concrete.

2. Rosie Mobile Work Station. RedZone Robotics developed the Rosie Mobile Workstation which is an electro-hydraulic, omni-directional locomotor platform with a heavy manipulator mounted on its deck. The heavy manipulator boom can deploy a large number of tools for demolition and decontamination. Alternatively, it can carry one or two smaller manipulators for more dexterous work using remotely operated tools. Ongoing tasks for Rosie at CP-5 include size-reduction of reactor shield plugs, horizontal thimble removal, waste packaging, and biological shield demolition.

B. Fernald Plant-1 LSDP

This project focused on the decontamination and dismantlement of the Plant-1 complex at the Fernald Environmental Management Project (FEMP). The Plant-1 complex consisted of Building 1A and six other buildings. Building 1A was a four-story building that was used to receive all enriched-uranium materials that were processed at the Fernald Site. Other smaller buildings in the Plant-1 complex included two storage sheds, two drum storage buildings, a drum reconditioning building, and a thorium warehouse. Activities consisted of decontaminating and dismantling the buildings and their contents. The D&D of Plant-1 was the first of more than 20 work packages of similar scope at FEMP.

The Integrating Contractor Team is comprised of Fluor Daniel Fernald, Fluor Daniel Irvine, Halliburton Nuclear Utility Services, Jacobs Engineering, Babcock and Wilcox Nuclear Environmental Services Incorporated, and Foster Wheeler Environmental Corporation. This LSDP began in January 1996.

About 12 innovative technologies will be demonstrated during this project. Many of these technologies are listed in Table 2. The following information highlights a technology demonstrated during the Fernald Plant-1 LSDP.

1. Oxy-Gasoline Torch. The oxy-gasoline torch (Figure 1) was demonstrated in the Fernald Plant-1 LSDP to cut metal faster, cleaner, and at lower cost than the widely used oxy-acetylene torch. During the demonstration, each torch cut through about 300 inches of thick-walled equipment, vessels, and shield walls ranging from 0.5 to 4.5 inches in thickness. Molten metal and slag tends to re-solidify when cutting metal with the oxy-acetylene torch. Because of this, several passes were often necessary with the oxy-acetylene torch to completely cut through the metal. This problem was not observed when cutting with the oxy-gasoline torch which was able to cut through a two-inch thick plate twice as fast as the oxy-acetylene torch. In addition to time and labor savings, the gasoline for the oxy-gasoline cutting torch costs about

\$3 for the same amount of cutting provided by \$32 worth of oxy-acetylene.

Figure 1: Oxy-Gasoline Torch



C. Hanford C-Reactor LSDP

The third LSDP is the C-Reactor Interim Safe-Storage Project. C-Reactor is a full-scale plutonium production reactor located at DOE's Hanford Reservation. The scope of this project is to place the C-Reactor facility in a low-cost, safe-storage condition for up to 75 years pending its final disposal. Activities include the demolition and removal of the 105-C building structure around the reactor block and the removal of the fuel storage basin. The Interim Safe-Storage Project will reduce the footprint of the C-Reactor facility by about 70% and significantly reduce future annual surveillance and maintenance costs.

Thirteen other DOE full-scale production reactors will benefit from technologies demonstrated at C-Reactor. Other large contaminated facilities, such as canyons (fuel reprocessing facilities) and gaseous diffusion plants selected for long-term storage, will also benefit from this interim safe-storage LSDP.

The Integrating Contractor Team is comprised of Bechtel Hanford, Bechtel National, Montgomery Watson, Morrison Knudsen, AEA Technology - United Kingdom, Washington State Department of Ecology, DOE Savannah River, CH2M Hill, Thermo Remediation, and International Technology.

At least 20 innovative technologies will be demonstrated during this project. Many of these technologies are listed in Table 3. The following information highlights a few of the technologies demonstrated during the C-Reactor LSDP.

TABLE 2
Technology Demonstrations at Fernald Plant-1

Technologies	Problem Area	Description
Field Raman Spectroscopy	Characterization	A fast and effective way to detect contaminants through in situ compound analysis
Laser-Induced Fluorescence Imaging	Characterization	A fast and accurate uranium characterization tool
Pipe Inspection System	Characterization	Involves a small monitor/VCR equipped with a tiny, light-bearing camera probe used to perform remote inspection and record results.
Sponge Jet Cleaning of Equipment	Decontamination	This technology is comparable to steam-jet cleaning or water washing technologies. However, since it does not use water, it can be used to clean material containing enriched uranium.
Steam Cleaning with Vacuum Recovery	Decontamination	This technology uses a pressurized, heated stream of water that flashes to steam when it impacts the surface being cleaned. The steam is then vacuum collected and recycled.
Oxy-gasoline Torch	Dismantlement	Low-cost, clean-cutting, highly-effective metal cutting technology
Vacuum Removal of Insulation	Dismantlement	System was used to efficiently remove rock-wool insulation from walls while controlling airborne contamination
Void Filling with Low-Density Cellular Concrete	Waste Management	Used to fill voids in hollow components to meet waste disposal cell acceptance criteria
Void Filling with Foam	Waste Management	Used to fill voids in hollow components to meet waste disposal cell acceptance criteria
Personal Ice Cooling System	Health and Safety	Incorporates small diameter tubing into a comfortable full-body suit. Chilled water is circulated through tubing which is attached to a pump unit and a small ice container

1. Hand-Held Hydraulic Shear. The Lukas model LKE 70 was the portable hydraulic shear (Figure 2) used at the C-Reactor LSDP. This shear has a built-in accumulator that uses approximately one pint of hydraulic fluid. The shear's weight is about 50 pounds and it is easy to carry and use. The shear has demonstrated good cutting capabilities for 1- and 2-inch pipes. Since the shear can cut small pipes attached to walls, the time required to dismount the piping is saved. Time is also saved since neither power supply lines nor hydraulic lines have to be maneuvered around obstacles. Shears also have the advantage of creating little or no airborne contamination and do not create potentially contaminated cutting debris.

2. Position Sensitive Radiation Monitor. This technology, owned by Shonka Research Associates, Inc., consists of a position-sensitive proportional counter that acts as the equivalent of hundreds of individual detectors aligned in a 4-foot long detector row. Commercially available software creates maps that display radioactivity levels without the need for human transcription. As a result, contamination is mapped faster, more accurately, and more completely than standard radiological survey processes. In addition, alpha and beta-gamma measurements are made in a single pass.

Figure 2: Hand-Held Hydraulic Shears



TABLE 3
Technology Demonstrations at C-Reactor

Technologies	Problem Area	Description
Laser-Assisted Ranging and Data System	Characterization	Performs accurate and repeatable radiological characterization surveys of indoor building surfaces. It is electronically coupled to a data collector (AutoCad).
Gamma Ray Imaging	Characterization	Provides a map of a dose rate of an area superimposed on its visible image
Position Sensitive Radiation Detector/Monitor	Characterization	This detector design turns one large gas-flow proportional counter into 400 or more accurate and sensitive mini-detectors. (Used for beta/gamma and alpha).
Concrete Shaving	Decontamination	This concrete decontamination system has shaving blades that remove precise layers, leaving a completely smooth, finished surface
Surface Decontamination *	Decontamination	Will test the ability of innovative technologies to remove surface contaminants from lead, concrete, and the asphalt emulsion covering the fuel basin
Structural Steel Decon / Recycling *	Decontamination	Will test the ability of innovative technologies to process and free release structural steel for reuse/recycle
Self Contained Pipe Cutting Shears	Dismantlement	Battery powered, hand-held, hydraulic mini cutter used for cutting 1" - 2" small bore piping.
Large Bore Pipe Cutting *	Dismantlement	Equipment/process that can cut large-bore, horizontally mounted pipe in a congested area, with or without asbestos, which is lightweight and generates low heat.
STREAM Management Database System	Health and Safety	STREAM (System for Tracking Remediation, Engineering, Activities & Materials) is a Management Database tracking system which provides a number of advantages such as visual and audio training, characterization information, waste tracking and manifests, and tracking of workers training and exposure records.
Mobile Integrated Temporary Utility System	Health and Safety	Integrated temporary power, communication, safety, and alarm systems
Self-Contained Air Cooled Respirator/Suits	Health and Safety	Liquid air, self-contained breathing and cooling system with duration of 2 hours worn as a backpack
Heat Stress Monitoring System	Health and Safety	On-line human monitoring system developed to provide monitoring where heat stress or other physiological safety issues are a concern
Sealed Seamed Sack Suits	Health and Safety	Lightweight, durable, waterproof and breathable protective coveralls are assessed against baseline cotton coveralls
Reactor Stabilization*	Stabilization	Spray-on coating, surface encapsulation to stabilize contaminants on reactor face

- - Demonstrations employ the use of a broad industry search to identify technologies that address these specific problems

IV. LSDP COMMUNICATION PROCESSES

Within two weeks following each technology demonstration, a one or two page fact sheet describing the demonstration is produced. Full demonstration results and cost and performance analysis of each of the demonstrated technologies is provided through publication of Innovative Technology Summary Reports which are also known as "Green Books." In addition, information about each LSDP and associated technology demonstrations is being provided on the LSDP Internet homepages which can be accessed through the D&D Focus Area homepage.

V. ACCELERATED SITE TECHNOLOGY DEPLOYMENT PROGRAM

The LSDP concept is an excellent approach to qualify D&D technologies for DOE's Accelerated Site Technology Deployment Program (ASTD). DOE's ASTD expedites decommissioning of surplus facilities by sponsoring implementation of previously demonstrated technologies at multiple facilities and sites. The demonstrated technologies are deployed to reduce the cost to decommission facilities, accelerate decommissioning schedules, and reduce DOE's mortgage to survey and maintain surplus facilities. Demonstration in an LSDP qualifies an innovative technology for the ASTD program if the full-scale cost and performance data collected during the demonstration indicates that the technology has advantages over the competing baseline technology.

Table 4

Internet Homepages for Current LSDPs

CP-5 LSDP	www.strategic-alliance.org
C-Reactor LSDP	www.bhi-erc.com/projects.htm
Fernald Plant 1 LSDP	www.fernald.gov/
D&D Focus Area	www.fetc.doe.gov/

VI. FUTURE LSDPs

The D&D Focus Area is currently evaluating candidate projects for the next two or three LSDPs to begin in fiscal year 1998. To address problem sets that have not been part of the first three LSDPs, the D&D Focus Area is targeting projects involving plutonium-contaminated gloveboxes, tritium-contaminated facilities, or facilities containing highly-enriched uranium. By selecting diverse types of facilities for the nine scheduled LSDPs, the D&D Focus Area expects to demonstrate the technical capability to cost-effectively and safely address 90% or more of the D&D problems identified by its customers.

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